$$\dot{n} = \frac{K_v \cdot p_{in}}{\sqrt{T_{in}}} \cdot \frac{p_{std}}{T_{std} \cdot R} \cdot \frac{\sqrt{M_{mix\text{-}cal}}}{\sqrt{M_{mix}}}$$

Eq. 1065.642-5

Where:

$$K_v = \frac{V_{stdref} \cdot \sqrt{T_{in\text{-}cal}}}{p_{in\text{-}cal}}$$

Eq. 1065.642-6

V_{stdref} = volume flow rate of the standard at reference conditions of 293.15 K and 101.325 kPa.

$T_{in\text{-}cal}$ = venturi inlet temperature during calibration.

$P_{in\text{-}cal}$ = venturi inlet pressure during calibration.

$M_{mix\text{-}cal}$ = molar mass of gas mixture used during calibration.

M_{mix} = molar mass of gas mixture during the emission test calculated using Equation 1065.640-9.

Example:

V_{stdref} = 0.4895 m³
$T_{in\text{-}cal}$ = 302.52 K
$P_{in\text{-}cal}$ = 99.654 kPa = 99654 Pa = 99654 kg/(m · s²)
p_{in} = 98.836 kPa = 98836 Pa = 98836 kg/(m · s²)
p_{std} = 101.325 kPa = 101325 Pa = 101325 kg/(m · s²)
$M_{mix\text{-}cal}$ = 28.9656 g/mol = 0.0289656 kg/mol
M_{mix} = 28.7805 g/mol = 0.0287805 kg/mol
T_{in} = 353.15 K
T_{std} = 293.15 K
R = 8.314472 J/(mol · K) = 8.314472 (m² · kg)/(s² · mol · K)

$$R = 8.314472 \text{ J/(mol·K)} = 8.314472 \text{ (m}^2\text{·kg)/(s}^2\text{·mol·K)}$$

$$K_v = \frac{0.4895 \cdot \sqrt{302.52}}{99654} = 0.000074954 \text{ m}^4 \cdot s \cdot K^{0.5}/kg$$

$$\dot{n} = \frac{0.000074954 \cdot 98936}{\sqrt{353.15}} \cdot \frac{101325}{293.15 \cdot 8.314472} \cdot \frac{\sqrt{0.0289656}}{\sqrt{0.0287805}}$$

$$\dot{n} = 16.457 \text{ mol/s}$$

[79 FR 23792, Apr. 28,2014]

§ **1065.644 Vacuum-decay leak rate.**

This section describes how to calculate the leak rate of a vacuum-decay leak verification, which is described in § 1065.345(e). Use the following equation to calculate the leak rate $\dot{n}_{leak}$, and compare it to the criterion specified in § 1065.345(e):

$$\dot{n}_{\text{leak}} = \frac{V_{\text{vac}}}{R} \cdot \frac{\left(\dfrac{p_2}{T_2} - \dfrac{p_1}{T_1}\right)}{\left(t_2 - t_1\right)}$$

Eq. 1065.644-1

Where:

V_{vac} = geometric volume of the vacuum-side of the sampling system.
R = molar gas constant.
p_2 = vacuum-side absolute pressure at time t_2.
T_2 = vacuum-side absolute temperature at time t_2.
p_1 = vacuum-side absolute pressure at time t_1.
T_1 = vacuum-side absolute temperature at time t_1.
t_2 = time at completion of vacuum-decay leak verification test.

t_1 = time at start of vacuum-decay leak verification test.

Example:

V_{vac} = 2.0000 L = 0.00200 m^3
R = 8.314472 J/(mol · K) = 8.314472 (m2 · kg)/(s2 · mol · K)
p_2 = 50.600 kPa = 50600 Pa = 50600 kg/(m · s2)
T_2 = 293.15 K
p_1 = 25.300 kPa = 25300 Pa = 25300 kg/(m · s2)
T_1 = 293.15 K
t_2 = 10:57:35 a.m.
t_1 = 10:56:25 a.m.

$$\dot{n}_{\text{leak}} = \frac{0.0002}{8.314472} \cdot \frac{\left(\dfrac{50600}{293.15} - \dfrac{25300}{293.15}\right)}{\left(10:57:35 - 10:56:25\right)}$$

$$\dot{n}_{\text{leak}} = \frac{0.00200}{8.314472} \cdot \frac{86.304}{70}$$

$$\dot{n}_{\text{leak}} = 0.00030 \text{ mol/s}$$

[79 FR 23795, Apr. 28, 2014]

§ 1065.645 Amount of water in an ideal gas.

This section describes how to determine the amount of water in an ideal gas, which you need for various performance verifications and emission calculations. Use the equation for the vapor pressure of water in paragraph (a) of this section or another appropriate equation and, depending on whether you measure dewpoint or relative humidity, perform one of the calculations in paragraph (b) or (c) of this section. Paragraph (d) of this section provides an equation for determining dewpoint from relative humidity and dry bulb temperature measurements.

The equations for the vapor pressure of water as presented in this section are derived from equations in ''Saturation Pressure of Water on the New Kelvin Temperature Scale'' (Goff, J.A., Transactions American Society of Heating and Air-Conditioning Engineers, Vol. 63, No. 1607, pages 347–354). Note that the equations were originally published to derive vapor pressure in units of atmospheres and have been modified to derive results in units of kPa by converting the last term in each equation.

(a) *Vapor pressure of water.* Calculate the vapor pressure of water for a given saturation temperature condition, T_{sat}, as follows, or use good engineering judgment to use a different relationship of the vapor pressure of water to a